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ABSTRACT

In order to interest women and minorities in science and teaching, a proposal by the Science Academy of Austin, Texas specifically recommended recruiting high school minority and female students as future science teachers, providing elementary students with opportunities to experience science, and increasing the number of women and minorities in the Science Academy program. A search of the literature was undertaken to explore the background conditions for these objectives. Five areas were investigated: (1) the attraction to teaching for minorities; (2) factors of mathematics and science teacher shortages; (3) sex-role models in science; (4) secondary school programs which promote science teaching as a career; and (5) business alliances with precollegiate science education. A list of 54 references is appended. (CW)

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Women, Minorities, and the Private Sector in Science and Mathematics Education

A Review of the Literature

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Women, Minorities, and the Private Sector in Science and Mathematics Education: A Review of the Literature

EXECUTIVE SUMMARY

Author: Patricia Hopkins

The Science Academy has received a grant from the National Science Foundation called Double TNT--Targeting New Teachers and Teaching by Novel Techniques. This literature review provides background on grant efforts to:

- Interest minorities and young women in science and in teaching;
- Improve precollegiate science teaching through a continued partnership with local business.

MAJOR FINDINGS

1. **The supply of minority teachers is insufficient and decreasing.** The number of bachelors degrees in education dropped by 52% for Blacks and 11% for Hispanics between 1975-76 and 1982-83. More minority teachers (41%) than other teachers (25%) report they are likely to leave teaching. (pp. 2-3)

2. **A shortage of mathematics and science teachers exists.** Contributing factors include:
   - Low starting salaries and low maximum salaries,
   - Job monotony,
   - Poor job availability,
   - Lack of job security, and
   - Discouragement from teaching by family, counselors, friends. (pp. 4-7)

3. **Females are less likely than males to enroll in advanced science and mathematics classes or to enter some scientific fields** (only 9% of engineers and scientists are women). The number of female science teachers also declines from 78% at grades K-3 to 24% at grades 10-12. Studies suggest there are no inherent barriers to women or minorities participating successfully in science or mathemetics; formal sex role modeling in the classroom has shown promise as one way to improve attitudes. (pp. 9-11)

4. **The Science Academy is one of only a few public school programs in the nation specifically designed to encourage students to enter teaching as a career.** (pp. 11-12)

5. **Business has contributed to precollegiate science education,** most commonly by:
   - Lending executives to schools,
   - Promoting adopt-a-school programs,
   - Supporting student or teacher internships
   - Contributing equipment and facilities,
   - Providing summer employment for students and teachers. (pp. 12-15)

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DISCLAIMER

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

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INTRODUCTION

The grant proposal submitted by the Science Academy of Austin to the National Science Foundation for 1988-89 contained two principal goals. The proposal, entitled "Double TNT" for "Targeting New Teachers & Teaching by Novel Techniques," was designed to interest minorities and young women in both science and teaching, and to improve science teaching in elementary and secondary schools through a continued partnership with local business.

In order to interest women and minorities in science and teaching, the proposal specifically recommended:

- "recruiting high school, minority students as future science teachers,"
- "providing the opportunities for elementary students to see themselves as future science teachers and Science Academy students," and
- "increasing the number of minorities and women in the Science Academy program" itself.

A search of the literature was undertaken to explore the background conditions for these objectives. The shortage of minority and mathematics and science teachers, the continuing dearth of women in scientific fields, and the levels of participation in science education by other schools and businesses were investigated by a literature search through the Educational Research Information Clearinghouse (ERIC).

Specifically, five questions were asked in this literature review:

1. Are minorities being attracted to teaching as a career?
2. What factors are at work in the mathematics and science teacher shortage?
3. What is known about sex-role models and women in science?
4. Are there other secondary school programs promoting teaching as a career?
5. How has business allied itself with precollegiate science education elsewhere?

1. ARE MINORITIES BEING ATTRACTED TO TEACHING AS A CAREER?

MINORITY INTEREST IN TEACHING

While research is conflicting on whether or not there is a national teacher shortage overall (Feistritzer, 1988; Mark & Anderson, 1985), the evidence that minorities are failing to enter teaching is becoming more and more pronounced. From 1975-76 to 1982-83, for example, the number of bachelor's degrees in education received by Blacks nationally declined by 52% from 14,209 to 6,792. The decline for Hispanics was 11% -- from 2,831 to 2,517 (Rodman, 1985). Between 1970 and 1982 the number of all college freshmen indicating teaching as a probable career fell from 19% to less than 5%, and for Blacks scoring high for college entrance on the Scholastic Aptitude Test (SAT), fewer than 1% of the students indicated an interest in education as a college major (Leonard, Kapel, & Williams, 1987; Graham, 1987).

TEACHER TESTS AND MINORITIES

The failure rates for minorities on teacher competency tests are limiting their entrance into the profession, as well. Not only in Texas, but also in Georgia, Oklahoma, California, and other states, high failure rates prevail (Anrig, Goertz, & McNeil, 1986). In Texas, in particular, 53% of the tests taken by Blacks and 38% of those taken by Hispanics were failed on the Examination for Certification of Educators in Texas (ExCET) in 1987, compared to 11% of those taken by Anglo/Others; and 61% of Blacks and 50% of Hispanics failed the Pre-Professional Skills Test, or P-PST, compared to 21% of Anglo/Others (Hopkins, 1988).

REMEDIATION FOR MINORITIES

Whether or not the teacher tests in use throughout the country have predictive validity or even content validity (Gifford, 1986), or are biased by race or by class, remediation for minorities taking tests appears difficult. Tests such as the P-PST or the National Teacher Examination (NTE) generally measure knowledge and abilities such as reading, writing, and mathematics, not teaching effectiveness or motivation techniques. In fact, some data show that prospective minority teachers perform better on tests of pedagogy than on tests of general knowledge (Anrig et al., 1986). Most researchers agree that the culprit for poor minority results on teacher tests is inferior education in general, not teacher education in particular (Gifford, 1986; Anrig, Goertz, & McNeil, 1986; Graham, 1987).

The evidence on remediation efforts is mixed: 40% of the retakes on the P-PST failed to change their scores (Garcia, 1986), but minority scores on the NTE at the University of Arkansas at Pine Bluff rose significantly following preparation and study for it (Haberman, 1988). The NAACP, having conducted successful SAT clinics for disadvantaged Black youth, plans to add prospective teachers to its project (Cole, 1986).

ATTRITION OF MINORITIES

Attrition for minorities in education is high. Of the 300 Blacks and Hispanics who responded to the Survey of the American Teacher (conducted by Louis Harris) this year, 41% stated they were likely to leave teaching within the next five years. In contrast, only a fourth of the non-minority teachers were similarly disaffected (Jennings, 1988). In a study for AISD, while 48% of Anglo/Other new hires left teaching in AISD within five years, 57% of new Black teachers and 58% of new Hispanic teachers left (Hopkins, 1988). (It is not known whether teachers then taught elsewhere.) These attrition rates which conform to national teacher profiles (Murnane, 1987; Heyns, 1988; Eberts, 1982). A Rand Corporation study, however, has found that roughly 40% to 60% of teachers who leave teaching eventually return (Rodman, 1987).

Age is an attrition factor, too. A large proportion of Black professionals and administrators in AISD are presently at or near retirement age, and the teaching profession itself is aging -- one half of the 2.2 million teachers in the country are expected to retire in the next five years (Tewel & Trubowitz, 1987). Seniority and tenure provisions secured by teacher unions may have contributed to the drop in minority teachers. The first teachers dismissed in economic hard times are usually those with least seniority, and minorities have customarily been the last hired. In addition, at least one study has revealed bias against women and minorities as an element in layoffs and reassignment of teachers in an urban school district (Webb, 1986).

PROPOSALS IN THE LITERATURE: MINORITY RECRUITMENT

According to the U.S. Department of Education's Office for Civil Rights, in 1982-83 Blacks made up 13% of the college-age population but less than 10% of those actually enrolled in college, while Hispanics comprised 7% of the college-age population but only 4% of college students (Rodman, 1985). It is a refrain in the literature that alleviation of the shortage of minority teachers must begin with increasing the number of minority students who go on to college (Olson, 1988). There is current evidence for a turnaround in the interest of minority students in attending college--23% of those taking the Scholastic Aptitude Test (SAT) last year were minorities, compared with only 11% in 1983 (Walsh, 1988).

Quite a few proposals for attracting minorities into teaching have been advanced:

- o High school students with an interest in teaching could be identified for a five-year, university liberal arts program. Supported by scholarships and internships, minority participants would take diagnostic tests and receive tutorials for skill development. After the bachelor's degree, these students would be guaranteed admission to California graduate schools of education for teacher training (Gifford, 1985).

- o Fellowships for education majors similar to the Ford Foundation's grants for minorities pursuing the Ph.D., and federal aid programs resembling the Reserve Officer Training Corps (ROTC) and the GI Bill could be enacted (Graham, 1987).

- o Internships for minority high school students to teach at elementary and junior high schools could be implemented (Tewel & Trubowitz, 1987), a concept contained in the Service to the District and Mini-Mentorship components of the Science Academy's "Double TNT" grant.

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2. WHAT FACTORS ARE AT WORK IN THE MATHEMATICS AND SCIENCE TEACHER SHORTAGE?

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DETERRENTS TO TEACHING MATHEMATICS AND SCIENCE

The fact that the demand for mathematics and science teachers exceeds the supply throughout the nation is well documented. In Texas, both of these teaching areas recorded shortages between 1981-82 and 1986-87, according to a review by the Texas Education Agency (TEA). At least half of the 72 districts surveyed reported shortages for mathematics and science teachers. A surplus of science teachers of almost 7%, however, is projected for the period 1987-88 to 1991-92, while a slight shortage for mathematics teachers (under 1% of 1986-87 employment) continues to be projected for Texas for the same period (Aki, 1987).

The deterrents from teaching for mathematics and science majors have been investigated in several studies. Evans (1987) sampled first-year students at a mid-western engineering school, to survey those who were "teaching oriented" but who had elected to pursue other careers.

The chief factors these students identified as deterring them from teaching were:

- Low starting salaries,
- Job monotony,
- Lack of job security,
- Low maximum salaries,
- Poor job availability, and
- Discouragement from teaching by family, counselors, or friends.

McManus & Matthews (1986) found the same considerations for non-education majors at the University of Georgia. Science majors differed significantly from education majors, considering salary, the job market, prestige, and opportunities for professional advancement more important factors than did the education majors in selecting a career.

INTEREST IN TEACHING ON THE RISE

A recent survey of over 200,000 first-year college students in the nation suggests that there is a rise in student interest in teaching as a career. The results of the survey, in fall, 1988, showed 8.8% of freshmen interested in teaching--compared to 8.1% the previous year, and to the all-time high of 23.5% in 1968 (Rothman, 1989).

A similar rise in interest was shown by students taking the two college admissions tests, the SAT and the American College Testing (ACT) program assessment. Seven percent of those taking the SAT in 1988 indicated their major would be education, compared to 6% in 1987. Of those taking the ACT in 1988, 8% were planning to major in education. Education as a major, however, was the fifth most popular choice of all students taking either examination, after business, social sciences, health services, and engineering (Walsh, 1988).

A 1982 study of high school seniors reported that 74% of the students had never had anyone--not teachers or counselors or parents--talk to them about teaching as a career. Only 1% of that sample from 10 southeastern states had a counselor raise the possibility of teaching as a career choice. More discouraging were the national results of an Educational Research Service survey in 1985 of 1,346 teachers: almost one-fourth of the teachers would not recommend teaching as a career, about half would recommend teaching to young people but with major reservations, and only one-fourth of those polled would recommend it without reservations (Evans, 1987).

Although interest in teaching is on the rise it remains minimal, far short of the projected need for new teachers. Trying to improve the image of the teaching profession is often touted as an aid to recruiting new teachers, but teaching itself is clearly regarded with ambivalence by its own

practitioners. Is teaching "the bottom rung on the professional career ladder," as some have indicated (Lyson & Falk, 1984)? Does it attract only those who are less able?

ARE TEACHERS AT THE BOTTOM OF THE LADDER?

A study of approximately 3,000 teacher education graduates of a medium-sized Ohio university concluded that in terms of academic ability and achievement, the best candidates did not go into teaching upon graduation, even after being trained and certified to be teachers (Pigge, 1985). Another study drawn from High School and Beyond (a national longitudinal database of almost 60,000 high school seniors and sophomores in 1980) suggested that those college-bound students aspiring to teach were, on the average, somewhat less able than those who aspired to other professions (Roberson, Keith, & Page, 1983).

SAT or ACT scores have been repeatedly lower for college freshmen planning to go into teaching than for others (Raizen, 1986; Walsh, 1988), although the Carnegie Foundation for the Advancement of Teaching found that the college grade point averages reported by working teachers in 1981 and 1985 were slightly higher than the averages reported by their cohorts in other professions ("Prospective Teachers," 1987). Teachers or teacher candidates, then, appear to do less well than others by achievement measures, like SAT scores or other standardized tests, but do better than those in competing professions by performance measures, like college grades.

PROPOSALS FOR RECRUITING TEACHERS

Arfin has reviewed the major student financial aid programs and their applicability to recruiting teachers (1985):

- Sponsored employment, providing part-time jobs to college students as teachers' aides, tutors, or library aides in local schools, could be modelled on the federal government's College Work Study program.

- Service-payback benefits in exchange for a commitment to service following graduation is the principle behind armed forces ROTC scholarships and the National Health Service Corps, and is adaptable as an incentive for teachers.

- The policy of loan forgiveness, cancelling part or all of a loan through specified service, however, has had disappointing results. For instance, participation in the Health Professions Student Assistance Program has been extremely meager, and the National Defense/National Direct Student Loans, which could be partially forgiven by teaching in public schools, have had minimal impact on the teacher supply.

- A Teacher Corps Fellowship Program to be established by the states would feature both service-payback and sponsored employment as financial incentives for attracting college students into teaching.

In the same vein but aimed at short-term teachers or those ambivalent about teaching or those seeking alternative service was a proposal for a domestic "educational peace corps" (Wimpelberg & King, 1983). Recruits to this program would be well prepared in liberal arts and sciences but with less than the traditional preparation in teaching methods and curriculum development.

Since fewer than 2% of chemistry, physics,and biology teachers are Hispanic, Rodriguez and Rodriguez have propounded student incentives as well as incentives for working teachers in other fields to increase the ranks of those teaching mathematics and science (1986). Attracting Hispanic or other youth into science teaching could be accomplished by symbols of recognition like letter jackets or assemblies, released time from regular classwork for peer teaching, and by apprenticeship programs in local industry. Recertification opportunities in science and mathematics for Hispanic teachers in subjects experiencing a surplus, paid sabbatical leaves for science and mathematics teachers working in low-income areas, and summer jobs in industry are incentives they mention for attracting minority teachers into these fields.

Graham suggested that mid-career professionals, not only Blacks but also other middle-aged, college-educated professionals, are likely candidates for a career change into teaching (1987). Military and government service are especially fertile areas for teacher recruitment. The recruitment and training of mid-career professionals is already an ingredient in several programs initiated around the country in response to the mathematics and science teacher shortage.

PROGRAMS FOR TRAINING MATH AND SCIENCE TEACHERS

The Ford Foundation sponsored a study by Coley and Thorpe of four initiatives in teacher education, three of which are aimed at mid-career professionals and the fourth of which is designed for recent college graduates who have not prepared to become teachers as undergraduates (1985). Another innovative program in teacher training at George Washington University focuses on professionals changing from non-teaching careers (Shotel,1987).

The five programs in detail are:

- Washington University teamed with the Monsanto Company in 1983 to ease the growing shortage of high school science and mathematics teachers in the St. Louis area, and to place engineers experiencing layoffs in a declining economy into new careers. Its post-bachelor's program is directed toward students with little or no coursework in education but with a strong undergraduate preparation (or professional experience) in math and science.

- Harvard's nine-month Midcareer Math and Science Program enables mid-career professionals from technology, scientific research, and financial services to become certified secondary mathematics and science teachers.

- The one-year teacher preparation program for engineers, scientists, and mathematicians at the University of Vermont is also designed to prepare retiring professionals for secondary school positions.

- The Math/Science/Technology Education Project in Amherst, Massachusetts is a consortium formed in 1983 by a public school district in the Boston area, the Digital Equipment Corporation (DEC), and the University of Massachusetts at Amherst. The Education Project is a graduate degree program aimed at young people to lead to teacher certification in math and science. A 14-month training schedule includes coursework, teaching experience in a nearby high school, and employment in the education division of DEC. Following graduation with a master's degree and certification as a secondary school teacher, participants are committed to teach for at least three years, with part-time employment opportunities continuing at DEC (Coley & Thorpe, 1985; see also Clark, Johnson, Kessler, & Schultz, 1984).

- George Washington University in 1985 began a program designed to encourage persons in other careers to pursue a second career in teaching. Marketing efforts concentrate on military officers, government employees, and other business professionals in the Washington, D.C. area who are within several years of separation or retirement. The curriculum is individualized and fieldwork is emphasized, toward the goal of certification, not necessarily the awarding of a degree (Shotel, 1987).

3. WHAT IS KNOWN ABOUT SEX-ROLE MODELS FOR WOMEN IN SCIENCE?

THE TRAINING OF WOMEN FOR SCIENCE

Women as scientists are still a rarity, and women in secondary science and mathematics education remain uncommon. A study in 1984 reported that fewer than 9% of scientists and engineers at that time were female (Jones & Wheatley, 1988). Women, it was noted, who do select science tend to enter the biological (or "soft") sciences and medicine as careers. The numbers of women who select to teach science are also disproportionate, from large numbers in the lower grades to strikingly smaller numbers in the more advanced grades. In a 1977 study for the National Science Foundation, it was found that at grades K-3, 78% of science teachers were women; at grades 4-6, 67% of science teachers were women; at grades 7-9, 38% of those teaching science were women; but at grades 10-12, the ratio had shrunk to 24% women (Donovan, Fronk, & Horton, 1984).

High school enrollments for males and females in biology and chemistry are, in general, equal, but only about 10% of high school girls enroll in more advanced courses like physics. The most critical factor, according to Jones and Wheatley (1988), is the low enrollment of women in the study of mathematics: 92% of the women in the 1972 freshmen class at the University of California at Berkeley, they found, lacked sufficient preparation in mathematics for undergraduate majors in the sciences (and subsequent job opportunities). A decade later, however, enrollment of women in high school mathematics courses in preparation for college was steadily increasing. Of college-bound seniors in 1981, 82.4% of females (and 89.8% of males) had completed three or more years of mathematics (Smith & Erb, 1986).

While research has indicated sex differences in quantitative ability, it is inconclusive (Jones & Wheatley, 1988). An assessment by the American Association for the Advancement of Science (AAAS) of successful mathematics and science intervention programs in kindergarten through twelfth grade flatly states that the programs demonstrate "there are no inherent barriers to the successful participation of minorities and women in science or mathematics" (Malcom, 1983). A study of the relationship of sex, achievement, and science self-concept to the career preferences of Black students in an inner city junior high school found that gender, not achievement, was the strongest predictor of science career preferences. The author's conclusion: "Factors other than ability account for the under-representation of women in 'hard' science fields" (Jacobowitz, 1983).

Jones and Wheatley, in their review of the literature on influences on women entering science, describe some of the factors that may be liable for women not entering scientific fields (1988). They characterize sex differences in learned helplessness, peer influences, differential treatment in the classroom, teacher expectations, and teacher perceptions as factors prohibiting girls from developing traits associated with scientific pursuits. If teachers treat students differently in science classes, in other words, "the educational system may be a vehicle for the transmission of institutional sexism."

SEX-ROLE MODELS

Donovan studied 30 eighth-grade science teachers (14 men and 16 women) and their interaction with almost 2,000 Florida students over the school year 1981-82 (Donovan et al., 1984). He found that the career interests of female students were not influenced by the sex of the teacher. It is possible that scientific and engineering career interests of students are formed prior to the eighth grade, Donovan concluded, or, since the teachers thought of themselves as teachers and not as practicing scientists, they were not strong enough role models even over an eighth-month period to affect career interests of their students.

Smith and Erb (1986), on the other hand, found that students in eight cities in middle schools/junior high schools exposed to women science career role models for two months were positively affected toward scientists and toward women in science. Attitudes of both male and female students in the experimental groups changed significantly after being visited in the classroom by at least three women scientists, after hearing about at least six important contributions by women to science, and after reading about at least six women in science. Moreover, the authors maintain, by bringing in community resource people, including women, and adapting the curriculum, this positive effect can be carried out by regular classroom teachers as part of their ongoing instruction.

A manual by Shaw and Underiner of sex equitable strategies for bringing career education into mathematics and science classrooms is based on the same premise, that a formal process of career education by classroom teachers can combat "career decisions based on emotions, sex role stereotyping, and misinformation" (1983). Their manual includes strategies for encouraging nontraditional careers (surveys, checklists for awareness-raising, discussion examples); interviews providing role models of women in welding and engineering and of handicapped and minority women in science; a career navigation paradigm; and examples of career education by industry, a university, and the local community. Not only is the manual designed to help young women of high school age prepare for

changing roles and professional equity, but it is also designed to increase the technological literacy of all students.

4. ARE THERE OTHER SECONDARY SCHOOL PROGRAMS PROMOTING TEACHING?

THE SCIENCE ACADEMY'S "DOUBLE TNT" IS UNUSUAL

Austin's Science Academy is unusual in providing high school science and mathematics students the opportunity to teach younger children.

Articles about well-known examples of magnet programs in other areas of the country--Thomas Jefferson High School for Science and Technology in Fairfax County, Virginia, a regional public school in the sciences, (Sawyer, 1986); the North Carolina School of Science and Mathematics in Durham, North Carolina, a residential magnet school (Sendor, 1984); the Computer Literacy Program at Lyons Township High School in LaGrange, Illinois (Borman & Lykos, 1983); the Burke High School in Massachusetts (McDowell, Wiske, Browne, Holland, & Saunders, 1987); or the High School of Telecommunication Arts and Technology in Brooklyn, New York (Rakovic, 1987)--fail to mention students teaching students as part of the curriculum or of planned extracurricular activities. The only two programs appearing in the literature search resembling the teaching innovations at the Science Academy are the Educators 2000 Project in New Orleans and a magnet school for the teaching professions in Houston.

THE EDUCATORS 2000 PROJECT (NEW ORLEANS)

The Educators 2000 Project is a cooperative effort among several Louisiana universities, the Urban League, and the Orleans Parish Public Schools focusing on recruiting students, particularly minorities, into education careers (Leonard et al., 1987). The program features early recruitment of low income, inner-city, minority junior high or middle school students with an interest in teaching, and provides continued encouragement through college graduation and placement in a job as a teacher. Students at the lower levels and in high schools tutor other students or serve as teacher aides, and their interest in teaching is reinforced by Educators 2000 clubs in the schools sponsored by local colleges or universities.

THE HIGH SCHOOL FOR THE TEACHING PROFESSIONS (HOUSTON)

The High School for the Teaching Professions, a magnet-school-within-a-school at the Stephen F. Austin Senior High School in Houston, was established in 1983-84 to develop college-bound students for careers in education (Spuck, 1987). The Houston Independent School District, more than three times the size of the Austin Independent School District, already had magnet programs in aviation, law enforcement, the performing arts, and the engineering and health professions (Rodman, 1988). Atlanta and Los Angeles have followed Houston's innovation in providing a magnet program for prospective teachers. Senior year students in the Houston program take a paid internship in classrooms in elementary schools in the district, so that each twelfth grader spends two hours a day, four days a week, in observation and interaction with the children.

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5. HOW HAS BUSINESS ALLIED ITSELF WITH PRECOLLEGIATE SCIENCE EDUCATION ELSEWHERE?

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NATIONAL SURVEY OF PARTICIPATION BY BUSINESS IN EDUCATION

A Conference Board survey of over 500 business executives and their attitudes toward corporate involvement in public education noted that while traditional programming such as summer jobs and Career Days continues, other partnership activities are becoming common (Lund & McGuire, 1983). The survey concluded:

- About 60% of the responding companies lent executives to serve as classroom teachers, consultants, and program developers; 75% of the companies studied said they encouraged employees to serve as volunteers or as elected officials on school administrative bodies.
- Almost 40% of the companies surveyed reported that they engaged in an adopt-a-school program or similar relationship with a single school.
- Approximately 60% of the businesses provided internships for students or other forms of cooperative education programs.
- Two out of three of the major corporations surveyed assist local schools by providing equipment, study materials, and facilities; 55% of the surveyed companies made financial contributions to schools, although most of the businesses did not favor providing direct grants to

schools as the most effective way of improving secondary education.

PERSONNEL CONTRIBUTIONS BY BUSINESS TO EDUCATION

Business and industrial executives on loan to schools serve as resource speakers in the classroom, technical advisors, and career counselors. By serving on advisory boards to science education programs, in the same way that local industry and business leaders serve on the Science Academy Advisory Board, private sector individuals can influence policy as well as procedures (Glass, 1983).

Ploch, in a 1984 article in High Technology, summarized numerous efforts by business to lend employees to schools or otherwise contribute personnel for workshops, seminars, and other educational projects. Corporate sponsors mentioned in the article include:

- Kaiser Aluminum and Chemical Corporation (Oakland, California) and Arco (Philadelphia) give employees paid time away from work for their volunteering in schools; the Institute of Electrical and Electronic Engineers (IEEE), a professional organization, encourages its members to volunteer in local schools.

- More than 1,000 companies have adopted schools in Dallas, and most send tutors to help individual students; the Science Consultants Program of Xerox Corporation (Rochester, New York) sends employees twice a month to local elementary schools using instructional kits developed and supplied by the company.

- Bell Labs and IBM are national corporate sponsors for Project SEED, a mathematics enrichment program to boost academic achievement of minority students, and sponsors in Dallas include Texas Instruments and Southwestern Bell.

- Honeywell (Minneapolis) supported Summatech magnet school by contributing 62 volunteers in the planning year; Xerox and IBM each lent a staff person full-time to the School of Science and Technology (Fairfax, Virginia) to assist with preliminary fundraising efforts.

Two other examples of personnel contributions by industry, mentioned in a 1985 Science Teacher article by Hamilton, Glass, Peyton, Mocherman, & Finley, are:

- The New England Power Company and the New England Power Exchange, with the National Science Teachers Association (NSTA), held a Teachers Honors Energy Workshop in the Boston area for two weeks in 1984 at industry sites with industry scientists serving as instructors.

- Sandia National Laboratories (Albuquerque, New Mexico) and other high technology firms, with the local medical school and area universities, provided substitute teachers in the public schools for science teachers to be able to attend a two-day NSTA convention.

In AISD, the Adopt-A-School program pairs businesses with schools in the District, and Project Mentor, staffed full-time by an IBM executive on loan to the District for a year, recruits role-models for identified at-risk students through existing school-business partnerships.

FINANCIAL CONTRIBUTIONS BY BUSINESS TO EDUCATION

Donations of books, surplus or outdated equipment, films, and consumable supplies are examples of material contributions by business to precollegiate education. Facilities are also frequently made available for field trips and as instructional laboratories for secondary students. Employment of students or of teachers in the summer, and direct scholarships, awards, or fellowships to both students and teachers are other means of financial assistance to education provided by business. Examples of financial contributors from the article by Ploch (1984) include:

- General Electric is contributing $1 million a year in programs across the country encouraging minority youth to pursue technological and scientific careers.

- Digital Equipment Corporation, with the University of Massachusetts at Amherst, supplies economic incentives for training mathematics and science teachers (a fuller description is on page 8); Arco, with the University of Texas at Dallas and the Council for Basic Education, supports a summer institute to retrain teachers in other disciplines for teaching mathematics and science; and IBM underwrites summer sessions in 25 states to teach teachers how to use and how to teach with microcomputers donated by the company to their schools.

- IBM contributed to the funding of the North Carolina High School of Science and Mathematics, a statewide residential public high school which draws most of its operating and capital monies from businesses and foundations.

- Ciba-Geigy (Ardsley, New York) presents annual $1,000 awards to science teachers at all grades; with the Los Angeles Educational Partnership, Arco backs a summer symposium for 35 outstanding mathematics and science teachers, selected by peers.

- Standard Oil (Ohio) and other sponsors, with the Cleveland Teacher Internship Program, places teachers in summer jobs; and Honeywell (Minneapolis) offers summer jobs to local mathematics and science teachers.

- CNA Insurance Companies, the National Society of Professional Engineers, the National Council of Teachers of Mathematics, and the National Science Foundation formed MathCounts for creating and providing materials to serve students in all 50 states.

Other financial contributions by industry to education are described by Hamilton et al. (1985):

- Iowa Utility Association, representing investor-owned utilities, supported a summer research enrichment program for high-achieving science students at Iowa State University by providing funding for room and board and tuition for all students.

- Rolscreen Company sponsors awards and Pioneer Hi-Bred International provides grants for travel and research to students in the Iowa Junior Academy of Science.

The American Association for the Advancement of Science (AAAS) has been involved in several projects financed by corporate sponsors (Wrather, 1985):

- Carnegie Corporation of New York funds the National Forum for School Science to focus attention on critical aspects of science education.

- Phillips Petroleum Company underwrites Challenge of the Unknown, providing materials and films to middle grades for solving problems with mathematical applications; and Standard Oil Company (Ohio) finances Science Resources for Schools, including teacher booklets, student activity sheets, posters, and other materials for junior high and middle schools.

PRIVATE BROKERS FOR BUSINESS PARTNERSHIPS

Private foundations and state and federal agencies often network with corporate donors to match schools' needs with business resources. Ploch (1984) mentions three of these private brokers:

- Public Education Fund (Pittsburgh), a national organization that helps to establish educational partnerships;

- San Francisco Education Fund, a community-based nonprofit group and one of more than 100 private foundations in California working to benefit public schools; and

- The Metropolitan Consortium for Minorities in Engineering (METCOM) in Washington, D.C., which organizes volunteers from government and industry to give presentations to high school students on engineering jobs.

Two other private brokering arrangements are mentioned by Hamilton et al. in Science Teacher (1985):

- A Sarasota, Florida high school created a nonprofit foundation to solicit funds from community groups and then invest them for a school endowment fund; and

- Oak Ridge Associated Universities in the Oak Ridge, Tennessee area works with corporations and government agencies to produce traveling programs about energy for presentation in school assemblies.

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